



**United States Air Force**  
**PDB Sampler Demonstration Work Plan**  
**Hickam AFB, Hawaii**  
**Draft Work Plan**

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**Prepared For:**

**Air Force Center For Environmental Excellence**  
**Brooks AFB, Texas**

**&**

**Headquarters Pacific Air Forces**  
**Hickam AFB, Hawaii**

**Prepared By:**

**Earth Tech, Inc.**

**San Antonio, Texas**

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## List of Acronyms

AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
CAS	Columbia Analytical Services
DO	Delivery Order
DOH	Department of Health
GC	Gas Chromatograph
HQ	Headquarters
IDW	investigation derived waste
LDPE	low-density polyethylene
ml	milliliter
MW	Monitoring Well
PACAF	Pacific Air Forces
PDB	Passive Diffusion Bag
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SRI	Scientific Research Instrument
TOC	Top of Casing
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound
WP	Work Plan

## **1.0 INTRODUCTION**

Earth Tech, Inc. (Earth Tech) has been tasked by the Air Force Center for Environmental Excellence (AFCEE) to perform Passive Diffusion Bag (PDB) sampler demonstration at Hickam Air Force Base (AFB), Hawaii. The work will be performed under Contract Number F41624-00-8023, Delivery Order (DO) 0014. The PDB samplers will be used to collect volatile organic compound (VOC) concentrations in groundwater monitoring wells (MWs) at Hickam AFB. The PDB sampler demonstration will be performed in accordance with the current PDB Sampler User's Guide developed by the U.S. Geological Survey (USGS).

In addition to the proposed PDB sampler demonstration study at Hickam AFB, PDB demonstration studies will also be conducted at Andersen AFB, Guam and Eglin AFB, Florida as part of this DO.

This Work Plan (WP) provides a description of proposed activities for the PDBS demonstration. A review of the PDB sampler technology and the study objectives are presented in Section 2. Section 3 presents the well selection criteria and outlines the field activities. Data evaluation and reporting activities are provided in section 4, while section 5 presents a proposed schedule for the field and reporting activities. Section 6 lists the points of contact at AFCEE, Hickam AFB, Headquarters (HQ) Pacific Air Forces (PACAF), and Earth Tech. Section 7 lists the references, while the User's Guide and the Health and Safety Plan are presented in Appendix A and Appendix B respectively.

## **2.0 PDB SAMPLER TECHNOLOGY**

PDB samplers are suitable for obtaining VOC concentrations in groundwater MWs. A typical PDB sampler consists of a 1- to 2-foot low-density polyethylene (LDPE) lay-flat tube closed at both ends and contains deionized water. The sampler is typically positioned at the targeted depth in the well by attachment to a weighted line. Sometimes, a LDPE mesh cover is placed on the PDB sampler for protection against abrasion in wells and boreholes.

The amount of time that a sampler is left in the well depends on the time required by the sampler water to equilibrate with the ambient well water and the time required for the well to return to the ambient conditions. The equilibration time depends on multiple factors, including type of groundwater contaminants and the water temperature. In laboratory studies, most VOC compounds have been shown to equilibrate within 166 hours (Reference 1). The samplers are in place long enough for the water, contaminants, and flow dynamics to re-stabilize after sampler installation. Field tests indicate that two weeks of equilibration is adequate for many applications. In less permeable formations, or in colder groundwater ( $< 10^{\circ}\text{C}$ ), longer equilibration times may be required. For wells with saturated screened intervals longer than 10 feet, PDB samplers should be used in conjunction with borehole flowmeter testing or other similar techniques used to characterize the water bearing zones and vertical variability in hydraulic conductivity.

Recovery of the PDB samplers consists of removing them from the well and immediately transferring the water to 40-millileter vials for analysis. The water concentrations represent an integration of chemical changes over the most recent portion of the equilibration period (48 to 166 hours).

This sampling method has both advantages and limitations when compared to other sampling methods. Advantages include the potential to substantially reduce or eliminate purge water associated with sampling. The samplers are relatively inexpensive, and easy to install & recover. Since the samplers are disposable, there is no downhole equipment to be decontaminated, and field equipment such as pumps,

tubing and bailers are not required. The samplers can also be used to delineate contaminant concentrations across the screened interval. The PDB samplers are not subject to interference from turbidity, since the pore size of the LDPE is 10 angstroms or less.

The PDB samplers are not appropriate for inorganic ions, and have a limited applicability for non-VOCs. If the samples need to be collected at a point in time in aquifers where VOC concentrations change rapidly, the PDB samplers may not be appropriate, since they integrate concentrations over time. PDB samplers may not be appropriate if the well screen is less permeable than the aquifer or the sand pack, and in cases where the contamination lies above or below the well screen.

When attempting to determine the applicability of PDB samplers at a site, a side-by-side comparison with a conventional sampling technique is usually performed. The conventional sampling is performed soon after the PDB sampler retrieval, and samples from both sampling techniques are sent to the same laboratory to reduce analytical variability.

## **2.1 PDB SAMPLER DEMONSTRATION OBJECTIVES**

The main objective of the proposed demonstration is to field-test the PDB Sampler User's Guide and provide feedback to the Air Force and USGS on the applicability of this sampling technique at Hickam AFB. The demonstration will compare PDB sampling to conventional sampling techniques. Costs for both sampling techniques will also be evaluated during this demonstration study.

### **3.0 PROPOSED TASKS**

This section describes the proposed tasks for the PDB Sampler demonstration at Hickam AFB. All field activities for this effort will be performed in accordance with the Health & Safety Plan presented in Appendix B.

### **3.1 WELL SELECTION**

A review of the groundwater MW data for the VOC contaminated sites at Hickam AFB was performed by Earth Tech, AFCEE, USGS and Hickam AFB personnel to select potential wells for the proposed study. The following information was reviewed prior to selection of the wells:

1. Well location and construction details;
2. Well screened interval and water levels;
3. Presence of free product in the wells;
4. Presence of dedicated sampling pumps in the wells;
5. Site geology and hydrogeology; and
6. Well groundwater VOC concentrations.

Based on the review, fourteen (14) wells were selected for the proposed study at Hickam AFB. The well details are presented in Table 3-1. VOC contaminants in these wells consist primarily of petroleum hydrocarbons.

### **3.2 FIELD ACTIVITIES – IN-SITU BOREHOLE TESTS**

In accordance with the PDB Sampler User's Guide, borehole geophysical methods will be used to identify and characterize the vertical flow regime (within the screened interval) for wells having saturated screened-intervals of more than 10 feet. These wells include MW06 at SS01, GT-K5 at SS15, and



MW04 at SS13. Additional wells may be included for borehole testing, depending on the water levels in these wells. These geophysical logging techniques will include the following:

**Table 3-1: PDB Demonstration Well Information**

<b>Well ID</b>	<b>Well Diameter (inches)</b>	<b>Well Screened Interval (feet TOC)</b>	<b>Approx. Water Level ( feet TOC)</b>	<b>Saturated Screen Thickness (feet)</b>
SS11 MW08	4	4-14	7.14	6.86
SS11 MW05	4	4-14	6.22	7.78
SS01 MW08	4	4-19.5	9.5	10
SS01 MW12	4	9.5-24.5	16.44	8.06
SS01 MW02	4	9.5-24.5	15.8	8.7
SS01 MW06	4	9.5-24.5	9.71	14.79
SS01 MW11	4	9.5-24.5	14.81	9.69
SS15 MW02	4	7.5-17.5	14.98	2.52
SS15 MW04	4	5-15	7.5	7.5
SS15 GT-K5	4	3-20	7.37	12.63
SS15 MW05	4	1.5-14.5	7.5	7
SS13 MW04	4	5-19.5	7.2	12.3
SS13 MW17	4	5-15	5.57	9.43
SS13 MW10	4	5-15.6	6.74	8.86

TOC – Top of Casing

1. Fluid resistivity/temperature measurements in the saturated zone;
2. Heat pulse (HP) flow meter tests to measure vertical groundwater flow; and
3. Spinner flow meter tests to measure horizontal flow.

Both static (ambient) and steady state pumping conditions will be assessed using fluid resistivity, temperature, and flow meter probes. These methods will be used to profile movement of water within the screened section of each well. In addition, hydraulic conductivity values will be calculated for the flow zones. This data will help to accurately locate the diffusion bag sampler within a screened interval.

### **3.3 FIELD ACTIVITIES – PDB SAMPLER INSTALLATION**

Prior to installation of the PDB samplers, the well depth and water level will be measured in each MW to verify accuracy of the well-construction records and to check whether sediment has accumulated in the well. The PDB samplers will be installed in accordance with the procedures outlined in the User's Guide. PDB samplers for this demonstration will be purchased from Eon Products, Inc. The bags will be filled with deionized water (approx. 350 mL) at the site prior to installation.

Vertical profiling will be performed by installing multiple samplers in the wells. One PDB sampler will be installed for every 3 feet of saturated screen interval. The samplers will be installed using a braided polyester line with a stainless steel weight attached to the end of the line. The weight will be resting on the bottom of the well, with the line taut above the weight. Table 3-2 shows the number of PDB samplers to be installed in the proposed wells.

In conjunction with the proposed demonstration study, the USGS and the Air Force will be testing in-situ samplers for non-VOC contaminants. These samplers will be installed in the wells (Table 3-1) and will be co-located with the VOC PDB samplers. As part of the current effort, Earth Tech will assist in the non-VOC sampler installation, retrieval, sampling and analysis.

**Table 3-2: Proposed Number of PDB Samplers for Hickam AFB Wells**

<b>Well ID</b>	<b>Saturated Screen Thickness (feet)</b>	<b>No. of PDB Samplers</b>
SS11 MW08	6.86	2
SS11 MW05	7.78	2
SS01 MW08	10	3
SS01 MW12	8.06	2
SS01 MW02	8.7	3
SS01 MW06	14.79	5
SS01 MW11	9.69	3
SS15 MW02	2.52	1
SS15 MW04	7.5	2
SS15 GT-K5	12.63	4
SS15 MW05	7	2
SS13 MW04	12.3	4
SS13 MW17	9.43	3
SS13 MW10	8.86	3
		Total = 39*

\*Number of samplers in each well may vary based on water levels/tidal influences observed during the PDB installation.

### **3.4 FIELD ACTIVITIES – PDB SAMPLER RETRIEVAL AND SAMPLE COLLECTION**

After a two-week equilibration period, the PDB samplers will be retrieved in accordance with the User's Guide. Two samples (at least three 40-ml vials for each sample) will be collected from each PDB sampler, labeled and stored at approximately 40C. The protocol outlined in the User's Guide will be followed to minimize water agitation and VOC loss via vaporization. Unused water from the PDB sampler and decontamination water will be stored in approved containers. Potential discharge locations for these investigation derived waste liquids include the following:

1. Site SS01 IDW can be discharged into the bioslurper unit in operation at Site SS01.
2. Sites SS11, SS13, and SS15 water can be discharged into the bermed area at the Tank Farm for evaporation if approval from the State of Hawaii Department of Health (DOH) is obtained.
3. An additional option for liquid IDW disposal is through the wastewater contractor on base at Hickam AFB.

### **3.5 FIELD AND LABORATORY ANALYSES**

A SRI 8610C field GC equipped with a photo-ionization detector and a flame-ionization detector will be used to measure VOC concentrations from each PDB sampler. The field GC will be equipped with a ten port purge-and-trap autosampler to expedite the field analysis. The field GC will be calibrated every day using a three-point calibration curve, and at least one calibration check sample will be performed during the day.

For wells containing multiple PDB samples, the sample containing the highest benzene concentration will be sent to the laboratory for analysis via method SW 8260B. Benzene concentration is proposed as a selection criterion, since it has the most stringent groundwater protection standard among the petroleum hydrocarbon contaminants.

### **3.6 QUALITY ASSURANCE AND QUALITY CONTROL**

A PDB sampler will be filled with deionized water (PDB blank) prior to deployment, and will be stored for a two-week period. This water sample will be sent to the analytical laboratory for VOC analysis. The results will be used to determine if contaminants were inadvertently introduced into the PDB samplers during sampler construction or transportation, thereby eliminating the possibility of false positives after sampler recovery and analysis.

Field duplicate samples will be collected for two wells and sent for laboratory analysis. Groundwater sampling protocols outlined in the existing Hickam AFB Sampling and Analysis Plan (Reference 2) will be followed for all sampling-related activities. Columbia Analytical Services (CAS) has been selected as the analytical laboratory for this effort. CAS is providing analytical services for the on-going Hickam AFB monitoring effort, and is familiar with the existing SAP and the Quality Assurance Project Plan (QAPP). Duplicate samples (approx. 10%) will also be collected and analyzed for the field GC method.

Samples from two additional wells will be sent as duplicates to another AFCEE-approved laboratory (STL-Denver). This will allow comparison between the CAS and STL analytical data for these two wells, and will provide an independent check on the accuracy of the CAS data.

### **3.7 CONVENTIONAL MICROPURGE SAMPLING**

Following retrieval of the PDB samplers, micropurge sampling will be performed at each well for collecting groundwater samples. This sampling will be conducted in accordance with the existing SAP. Groundwater samples will be sent to CAS for analyses by method SW 8260B. The decontamination water from the sampling activities will be disposed in accordance with local, state, and Federal regulations.

## **4.0 DATA EVALUATION AND REPORTING**

This section describes the data evaluation and reporting tasks for the PDB sampler demonstration.

### **4.1 DATA EVALUATION**

Laboratory analytical data from the PDB and micropurge sampling efforts for VOCs will be evaluated by comparing the contaminant concentrations for each well. Regression plots will be used to compare the results from both sampling techniques. Statistical tests (e.g., test of means, paired t- tests) may also be used to compare the analytical data from the PDB samplers and the conventional techniques.

As mentioned in section 3, the sampler indicating the highest contaminant concentration in each well (analyzed using the field GC) will be sent to the laboratory for analysis via the SW8260B method. A qualitative comparison of these results will be performed to evaluate the correlation between the laboratory and field data.

Presence of vertical VOC contaminant stratification will also be evaluated by comparing the field GC data for the multiple samplers in each well. For wells MW06 at SS01, GT-K5 at SS15, and MW04 at SS13, the vertical contaminant stratification will be evaluated in conjunction with the in-situ borehole flowmeter data (which will indicate if there is significant vertical flow in these wells).

If PDB and conventional sampling indicate that VOC contaminant concentrations for each well are within a range (e.g.  $\pm 15\%$ ) deemed acceptable by Hickam AFB and the regulatory agencies, then PDB samplers may be approved for monitoring VOC concentrations in these wells. If contaminant concentrations from the PDB samplers are significantly different than the conventional sampling, further evaluations will be performed to determine the source of the difference. These evaluations will include review of the site geology, results of the vertical profiling and borehole measurements (if applicable).

As part of the data evaluation effort, sampling costs for PDB samplers for VOCs will be compared to the micropurge sampling techniques at Hickam AFB. This cost comparison, in addition to above evaluations will be used to determine the applicability of PDB sampling at Hickam AFB.

Evaluations of the non-VOC sampler data will be performed by the USGS. Results of these evaluations will be presented by the USGS, and may be included in the technical report, upon approval by AFCEE, USGS, and Hickam AFB.

## **4.2 TECHNICAL REPORT**

Results of the data evaluation efforts will be presented in a technical report. The technical report will also include the following:

1. Summary of the field activities;
2. Summary of field and laboratory analytical data;
3. Data evaluation procedures and results;
4. Results of the cost comparison between the PDB sampling and conventional technique; and
5. Site-specific parameters or conditions that could affect implementation of PDB samplers at Hickam AFB.

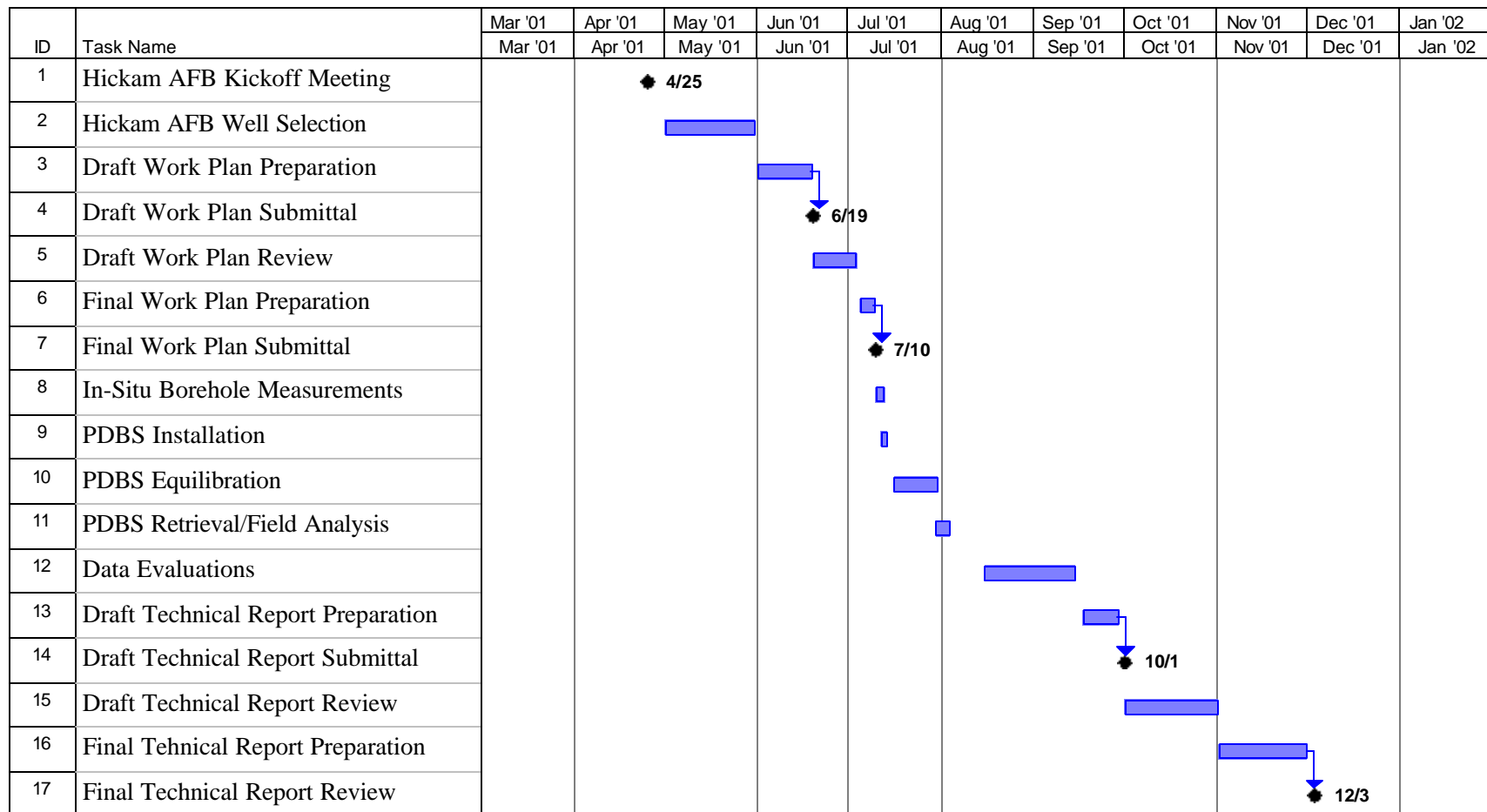
A draft version of the report will be posted on Earth Tech's web site for review by HQ AFCEE, HQ PACAF, Hickam AFB and the regulatory agencies (as appropriate). Comments from these agencies will be addressed and incorporated as appropriate into the final version. The web-site address is [www.et-sa.com](http://www.et-sa.com).

## **5.0 PROJECT SCHEDULE**

Figure 5.1 presents a proposed schedule for the field and reporting activities. The schedule assumes a 10-day review period for draft Work Plan and a 30-day review period for the Draft Technical Report.



**Figure 5-1 PDB Sampler Demonstration Project Schedule**



## **6.0 POINTS OF CONTACT**

This section provides the names, addresses, and telephone numbers of designated personnel who will serve as key points of contact during the project:

**Contracting Officer:**

**Ms Mary Jo Boldt**  
HSW/ PKVCB  
3207 North Road  
Brooks AFB, Texas 78235  
Tel: (210) 536-4980

**Contracting Officer's Representative:**

**Capt. Tasha L. Pravecek, Ph.D**  
HQ AFCEE Consultant Operations Division  
3207 North Road  
Brooks AFB, Texas 78235  
Tel: (210) 536-5286

**HQ PACAF Representative:**

**Mr. John Sullivan**  
HQ PACAF/CEVR  
25 E Street, Suite D306  
Hickam AFB, Hawaii 96853-5412  
Tel: (808) 448-0469

**Hickam AFB Representative:**

**Mr. Mark Peterson**  
15 CES/CEVR  
75 H Street, Bldg. 1204  
Hickam AFB, Hawaii 96853  
Tel: (808) 449-1584, ext. 204

**Contractor:**

**Earth Tech, Inc.**  
110 Broadway, Suite 320  
San Antonio, Texas 78205  
Tel: (210) 271-0925  
Project Manager: Mr. Manish M Joshi, P.E.

## **7.0 REFERENCES**

1. U.S. Geological Survey, User's Guide for Polyethylene-based Passive Diffusion Bag Samplers To Obtain Volatile Organic Compound Concentrations In Wells, Water-Resources Investigations Report 01-4060.
2. CH2MHILL, Work Plan for Interim Remedial Actions At Four Runway 8L Sites, Hickam AFB, Hawaii, October 2000.
3. Air Force Center For Environmental Excellence, Quality Assurance Project Plan, Version 3.0, March 1998.

**APPENDIX A**  
**PDB SAMPLER USER'S GUIDE**

**THE PDB USER'S GUIDE CAN BE VIEWED AT THE FOLLOWING ADDRESS:**

[www.itrcweb.org](http://www.itrcweb.org)

**APPENDIX B**  
**HEALTH AND SAFETY PLAN**